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An Experimental Analysis of the Relative Efficiency of Alternative Assignment Auction Formats

R. Wesley Nimon, PI

Achieving Human Resource Solutions Through Innovative Research

Efficiency and Auction Design Research

NPRST

- **Basic Research Addresses a Few Fundamental Questions**
  - How and what weight to apply to the Sailor's bid?
  - Does contention level matter?
  - Which auction format is more efficient? (1st vs. 2nd Price)

Background

- **Developed experimental software environment**
  - Results to empirically inform the auction design

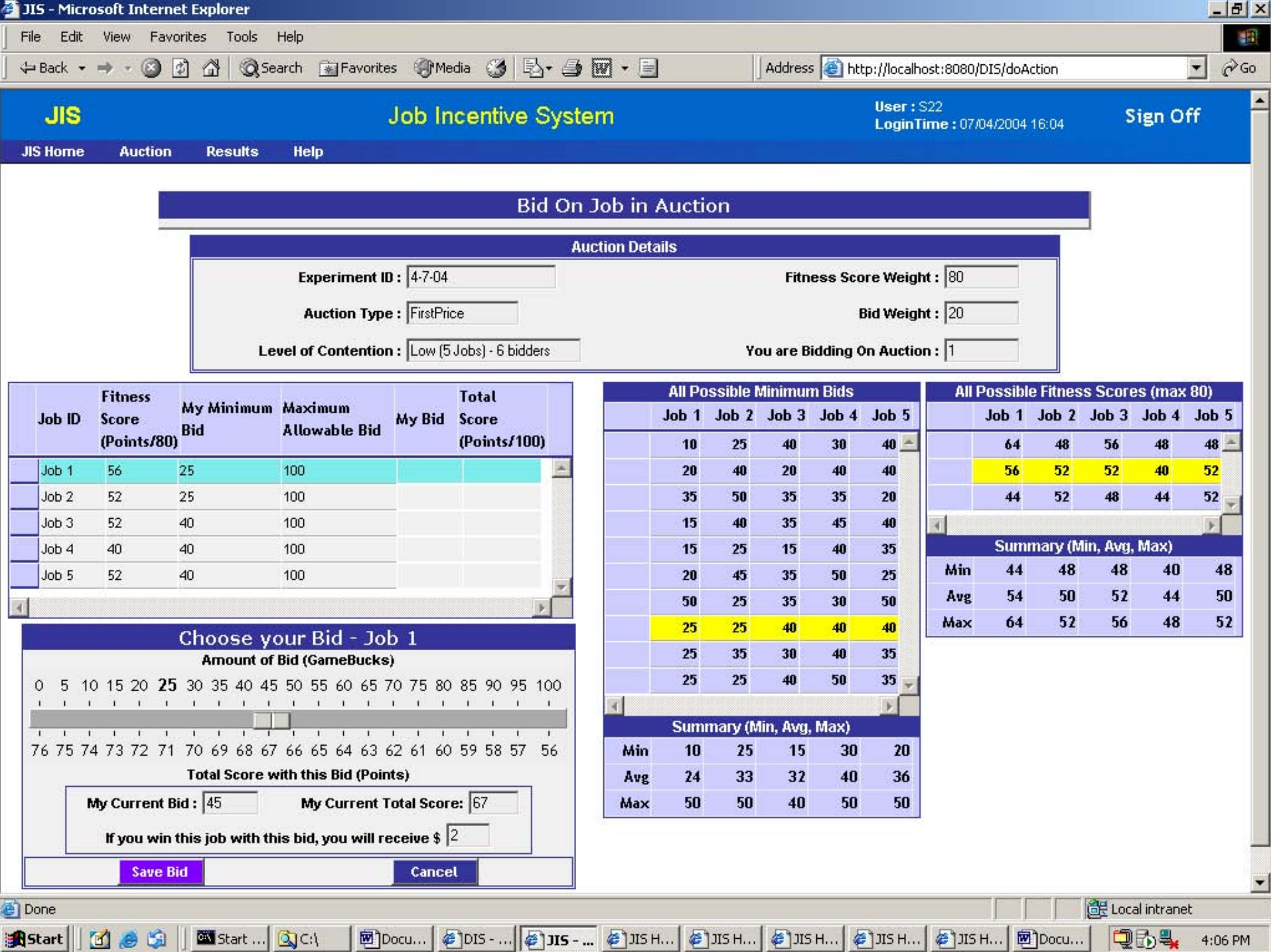
- **Conducted experimental auctions**
  - Southern Methodist University
  - University of Mississippi
  - University of Memphis

Basic Structure of the Experiments

- Subjects are presented with list of jobs
- Total Score = Fitness Score + Bid Score
- Optimization across Total Scores determines assignments
- For each job the bidder's reservation wage (RW) is given
- For the awarded job the subject receives Gamebucks = Bid-RW
- Subjects exchange their Gamebucks for US dollars at a pre-announced exchange rate. This is their payment.

Experimental Auction Environment
Subject's Screens

Achieving Human Resource Solutions Through Innovative Research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JIS
Job Incentive System
User : S22
LoginTime : 07/04/2004 16:04
Sign Off
JIS Home Auction Results Help
Bid On Job in Auction
Auction Details
Experiment ID : 4-7-04
Auction Type : FirstPrice
Level of Contention : Low (5 Jobs) - 6 bidders
Fitness Score Weight : 80
Bid Weight : 20
You are Bidding On Auction : 1
Job ID | Fitness Score (Points/80) | My Minimum Bid | Maximum Allowable Bid | My Bid | Total Score (Points/100)
Job 1 | 56 | 25 | 100
Job 2 | 52 | 25 | 100
Job 3 | 52 | 40 | 100
Job 4 | 40 | 40 | 100
Job 5 | 52 | 40 | 100
Choose your Bid - Job 1
Amount of Bid (GameBucks)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
76 75 74 73 72 71 70 69 68 67 66 65 64 63 62 61 60 59 58 57 56
Total Score with this Bid (Points)
My Current Bid : 45
My Current Total Score: 67
If you win this job with this bid, you will receive $ 2
Save Bid
Cancel
All Possible Minimum Bids
Job 1 | Job 2 | Job 3 | Job 4 | Job 5
10 25 40 30 40
20 40 20 40 40
35 50 35 35 20
15 40 35 45 40
15 25 15 40 35
20 45 35 50 25
50 25 35 30 50
25 25 40 40 40
25 35 30 40 35
25 25 40 50 35
Summary (Min, Avg, Max)
Min 10 25 15 30 20
Avg 24 33 32 40 36
Max 50 50 40 50 50
All Possible Fitness Scores (max 80)
Job 1 | Job 2 | Job 3 | Job 4 | Job 5
64 48 56 48 48
56 52 52 40 52
44 52 48 44 52
Summary (Min, Avg, Max)
Min 44 48 48 40 48
Avg 54 50 52 44 50
Max 64 52 56 48 52
Done
Local intranet
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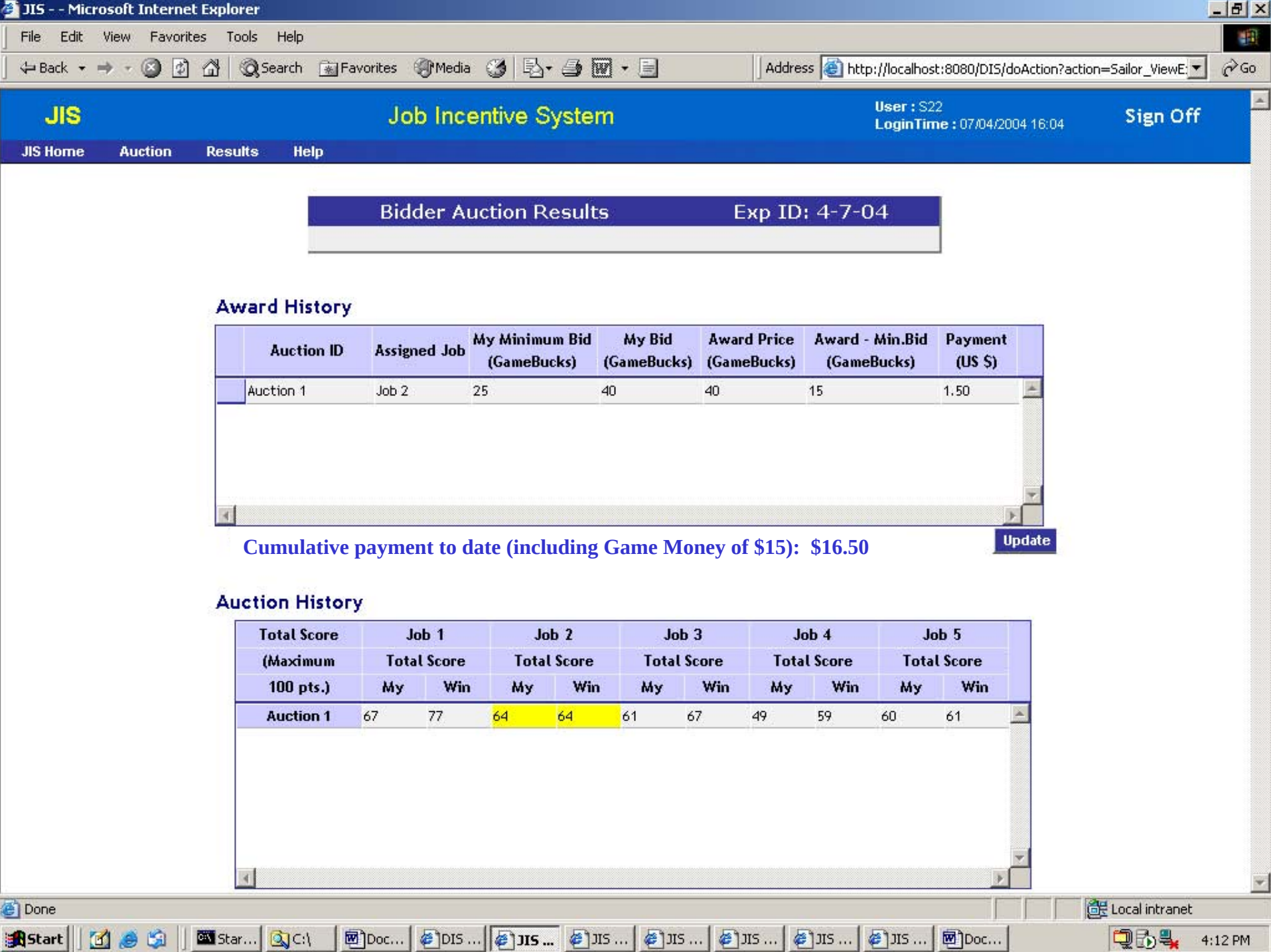
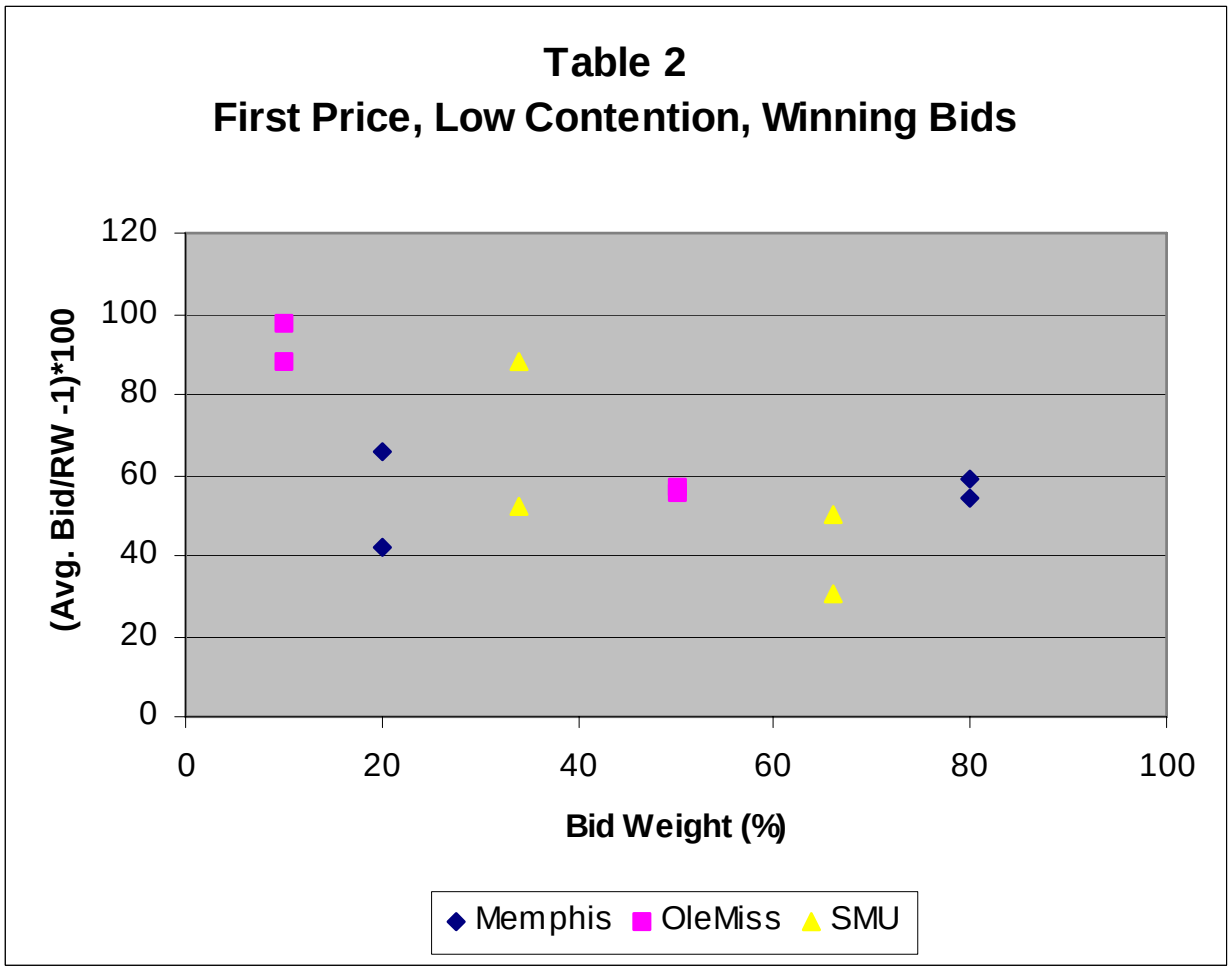

JIS - - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://localhost:8080/DIS/doAction?action=Sailor_ViewE:
Go
JIS
Job Incentive System
User : S22
LoginTime : 07/04/2004 16:04
Sign Off
JIS Home Auction Results Help
Bidder Auction Results Exp ID: 4-7-04
Award History
Auction ID | Assigned Job | My Minimum Bid (GameBucks) | My Bid (GameBucks) | Award Price (GameBucks) | Award - Min.Bid (GameBucks) | Payment (US $)
Auction 1 | Job 2 | 25 | 40 | 40 | 15 | 1.50
Update
Cumulative payment to date (including Game Money of $15): $16.50
Auction History
Total Score (Maximum 100 pts.) | Job 1 Total Score My Win | Job 2 Total Score My Win | Job 3 Total Score My Win | Job 4 Total Score My Win | Job 5 Total Score My Win
Auction 1 | 67 77 | 64 64 | 61 67 | 49 59 | 60 61
Done
Local intranet
Start
4:12 PM

First Price, Low Contention Auctions



Data

- **900 observations**
- **Only winning bids were used**
- **Initial rounds were excluded to account for improved level of task understanding**

$$\frac{\text{Bid}}{\text{RW}} = \hat{\beta}_0 + \hat{\beta}_1(\text{Auction Round \#}) + \hat{\varepsilon}\,.$$

- **Parameterization of Experiments**
  - **High (3 jobs/6 bidders) to Low (5 jobs/6 bidders) Contention Level**
  - **Bid Weights: 10%, 20%, 33%, 50%, 66%, & 80%**
  - **First Price**

Regression Model Estimated

$$\text{Bid} = \hat{\beta}_0 + \hat{\beta}_1 \text{Contention} + \hat{\beta}_2 \text{Memphis} + \hat{\beta}_3 \text{Mississippi} + \hat{\beta}_4 (\text{BidW})^{-1} + \hat{\beta}_5 \text{RW} + \hat{\beta}_6 \text{FS} + \hat{\varepsilon}$$

First Price Auctions
Dependent Variable: Bid
Rsquare = 0.63

Independent Variables

Intercept	Contention	Memphis	Mississippi	$(\text{BidW})^{-1}$	RW	FS
8.36	-24.42	0.07	1.05	12.51	0.759	0.146
2.99***	14.87***	0.13	1.47	12.9***	25.03***	4.08***

Elasticity Estimates

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- **Bid to Bid-Weight Elasticity (Low Contention)**

$$\varepsilon_{\text{Bid},\text{BidW}} = \text{-0.35 and -0.10}$$

at 10% and 50% Bid-Weights, respectively

  - Increase in Bid Weight from 10% to 50%
    - › Approximately a 28% reduction in bid amounts

Assessment of Market Power

$$Bid = \hat{\beta}_0 + \hat{\beta}_1(RW) + \hat{\beta}_2(Fitness) + \varepsilon .$$

Factors Limiting Market Power	Coefficient on the Fitness Score **Memphis**	**Mississippi**	**SMU**
Modified VL	**0.226** 3.7***	**-0.025** -0.4	**0.121** 1.6
High Contention Only	**0.279** 2.8***	**0.02** 0.19	**0.0268** 0.37
High Bid Weight Only	**0.121** 3.5***	**0.151** 4.9***	**0.219** 3.08***
High Bid Weight and High Contention	**-0.019** -0.2	**-0.079** -1.2	**0.043** 1.2

*** indicates significance at the P value< 0.01 level

Back-up Slides

1st Price vs. Generalized 2nd Price Auction

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1st Price Auction

- **Bid Weight = 2%**
- **Max Bid = $500**

- **Bids Received**
  - $500
  - $500
  - $500

Generalized 2nd Price Auction

- **Bid Weight = 2%**
- **Max Bid = $500**

- **Bids Received**

1st Price vs. Generalized 2nd Price Auction

NPRST

1st Price Auction

- **Bid Weight = 2%**
- **Max Bid = $500**

- **Bids Received**
  - $500
  - $500
  - $500

Generalized 2nd Price Auction

- **Bid Weight = 2%**
- **Max Bid = $500**

- **Bids Received**
  - $500
  - $350
  - $250

First vs. Second Price Auction Format

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First to Modified VL Auction

		% Change in Bid/RW and Payment	
		Bid-weight	
		20%	80%
Contention: High	Bid/RW	-24.6%	-6.9%
	Payment	60.2%	81.5%
Contention: Low	Bid/RW	-2.6%	-22.3%
	Payment	70.6%	8.3%